SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Shri Vile Parle Kelavani Mandal's

ITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBE JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India,

Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: B.Sc.

Course: Mathematics

Semester V & VI

Choice Based Credit System (CBCS) with effect from the Academic year 2020-21

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

DEPARTMENT OF MATHEMATICS

SYLLABUS

SEMESTER V

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc . (2021-22)		**Semester: V**
Course: Integral Calculus		**Course Code:USMAMT 501**

Teaching Scheme				**Evaluation Scheme**	
Lecture (per week) 48 mins× 3	**Practical (lectures per week) 48 mins× 3**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
3	3	NIL	4	25	75

Learning Objectives:

1.Demonstrate the basic ideas, tools and tecniques of integral calculus.

2.Tools and tecniques of integral calculus will use to solve problems from other branches of sciences

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Understand Fubini's Theorem and solve the applications.

CO2: Understand the change of variable formula and solve the applications using polar, cylindrical and spherical coordinates

CO3: Learn to apply the concept of multiple integrals to physical problems

CO4: Understand concept of line integral and its properties, applications.

CO5: Understand Green's theorem and solve the applications.

CO6: Understand Stokes' Theorem, Gauss' Divergence Theorem and solve problems on it.

CO7: Understand the Definition of surface integrals of scalar-valued functions as well as of vector fields defined on a surface and solve problems.

Outline of Syllabus: (per session plan)

Module		**Description**	**No of Lectures**
1		**Multiple Integral**	15
2		**Line Integral, Green's Theorem**	15
3		**Surface Integral, Stokes' Theorem, Gauss' Divergence Theorem**	15
		Total	**45**

PRACTICALS: 48 mins× 3 per batch per week

Module	Topic	No. of lectures/Credits
1	**(i) Definition of double (respectively: triple) integral of a function bounded on a rectangle (respectively: box), Geometric interpretation as area and volume.** **(ii) Fubini's Theorem over rectangles and any closed bounded sets, Iterated Integrals. Fubini's theorem over rectangles.** **(iii) Properties of Double and Triple Integrals: Formulae for the integrals of sums and scalar multiples of integrable functions, Integrability of continuous functions.** **(iv) Change of variables formula (Statement only), Polar, cylindrical and spherical coordinates and integration using these coordinates.** **(v) Applications to finding the center of gravity and moments of inertia.**	15/ 2.5
2	**(i) Review of Scalar and Vector fields on $\mathbb{R}^n$, Vector Differential Operators, Gradient Paths (parametrized curves) in $\mathbb{R}^n$ (emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$), Smooth and piecewise smooth paths, Closed paths, Equivalence and orientation preserving equivalence of paths.** **(ii) Definition of the line integral of a vector field over a piecewise smooth path, Basic properties of line integrals including linearity, path-additivity and behaviour under a change of parameters, Examples.** **(iii) Line integrals of the gradient vector field, Fundamental Theorem of Calculus for Line Integrals, Necessary and sufficient conditions for a vector field to be conservative, Green's Theorem. Applications to evaluation of line integrals.**	15/ 2.5

3	**(i) Parameterized surfaces. Smoothly equivalent parameterizations, Area of such surfaces. Definition of surface integrals of scalar-valued functions as well as of vector fields defined on a surface.** **(ii)Curl and divergence of a vector field, Elementary identities involving gradient, curl and divergence.** **(iii)Stokes' Theorem, Examples. Gauss' Divergence Theorem (proof only in the case of projectible domains), Examples.**	**15/ 2.5**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I

- Practicals will be conducted as per University notified list
- one practical(of three lectures) per week per batch.
- Batches will be formed as University norms

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.A./ B.Sc . / B.Com(2021-22)				**Semester: V**	
Course: Algebra				**Course Code: USMAMT502**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
3	3	-	2.5	25	75

Learning Objectives:

- Students will be able to explain Quotient space, eigen value and eigen vector of linear transformation and inner product space.
- Students will have a working knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group, order of an element and cyclic subgroups.
- Students will be introduced to and have knowledge of many mathematical concepts studied in abstract mathematics such as permutation groups, factor groups and Abelian groups.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: To understand and develop proofs of results on Quotient spaces.
CO2: To understand similar matrices and diagonalizable matrices
CO3: Explain the properties of and orthogonal linear transformation
CO4: Gains knowledge in group theory

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Quotient Spaces and Orthogonal Linear Transformations	15 lectures
2	Diagonalization of matrices	15 lectures
3	Groups and Subgroups	15 lectures
	Total	45 lectures

PRACTICALS

1. Practical on Quotient space
2. Practical on inner product
3. Practical on eigen values and eigen vectors
4. Practical on diagonalization
5. Practical on groups
6. Practical on subgroups
7. Practical on order of an element and cyclic group

Suggested Readings

(1) I.N. Herstein, Topics in Algebra.

Unit	**Topic**	**No. of Hours/Credits**
Module 1	a) Review of vector spaces over ℝ; subspaces and linear transformations. Quotient Spaces: For a real vector space V and a subspace W; the cosets v + W and the quotient space V /W. First Isomorphism theorem for real vector spaces (Fundamental theorem of homomorphism of vector spaces), dimension and basis of the quotient space V / W when V is finite dimensional. Real Orthogonal transformations and isometries of $\mathbb{R}^n$. Translations and Reflections with respect to a hyperplane. Orthogonal matrices over ℝ: b) Equivalence of orthogonal transformations and isometries of $\mathbb{R}^n$ fixing the origin. Characterization of isometries as composites of orthogonal transformations and translations. Orthogonal transformation of $\mathbb{R}^2$: Any orthogonal transformation in $\mathbb{R}^2$ is a reflection or a rotation. c) Eigenvalues and eigenvectors of a linear transformation $T : V \rightarrow V$ where V is a finite dimensional real vector space and examples, eigenvalues and eigenvectors of n n- real matrices, linear independence of eigenvectors corresponding to distinct eigenvalues of a linear transformation/matrix.	**15 lectures**
Module 2	a) Characteristic polynomial of an n × n-real matrix. Result: A real number is an eigenvalues of an n × n matrix A if and only if λ is a root of the characteristic	**15 lectures**

	polynomial of A. Cayley-Hamilton Theorem (statement only), Characteristic roots. Similar matrices and relation with a change of basis. Invariance of the characteristic polynomial and (hence of the) eigenvalues of similar matrices. b) Diagonalizability of an n × n real matrix and a linear transformation of a finite dimensional real vector space to itself. Definition: Geometric multiplicity and Algebraic multiplicity of eigenvalues of an n × n real matrix and of a linear transformation. Examples of non-diagonalisable matrices over ℝ. An n × n real matrix A is diagonalizable if and only if $\mathbb{R}^n$ has a basis of eigenvectors of A if and only if the sum of dimension of eigenvectors of A is n if and only if the algebraic and geometric multiplicities of eigenvalues of A coincide. c) Diagonalization of real Symmetric matrices and applications to real quadratic forms, rank and signature of a real quadratic form, classification of conics in $\mathbb{R}^2$ and quadric surfaces in $\mathbb{R}^3$.	
Module 3	a) Definition of a group, abelian group, order of a group, finite and infinite groups Properties of a group, Properties of order of an element b) Subgroups: Definition, necessary and sufficient condition for a non-empty set to be a Sub- group, center Z(G) of a group, Intersection of two (or a family of) subgroups is a subgroup, Union of two subgroups. c) Cyclic groups and cyclic subgroups, finite, infinite cyclic groups, generators. Subgroup of a cyclic group is cyclic.	**15 lectures**

(2) P.B. Bhattacharya, S.K. Jain, S. Nagpaul. Abstract Algebra.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc . (2021-22)				**Semester: V**	
Course: Analysis				**Course Code:USMAMT 503**	
Teaching Scheme				**Evaluation Scheme**	
Lecture Per week	**Practical (per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
3	3lectures	NIL	4	25	75

Learning Objectives:

(1) Identify the three properties of a metric or distance
(2) Define basic terms and concepts in metric space topology
(3) Prove theorems logically in metric space topology
(4) Use basic concepts in the development of Real analysis results

Course Outcomes:

After completion of the course, learners would be able to:

CO8: Able to understand the Euclidean distance function on $\mathbb{R}^n$ and appreciate its properties

CO9: Define convergence for sequences in a Metric space and determine whether a given sequence in Metric space converges

CO10: Distinguish between continuous functions and Uniform continuous functions

CO11: Use basic concepts in the development of Real Analysis results

CO12: Explain the definition of continuity of functions from $\mathbb{R}^n$ to $\mathbb{R}^m$ and determine whether a given function from $\mathbb{R}^n$ to $\mathbb{R}^m$ is continous

.

Outline of Syllabus: (per session plan)

unit	**Description**	**No of lectures**
1	Topology of Metric Spaces	15
2	Sequences in Metric Spaces	15
3	Continuous Functions	15
	Total	**45**
PRACTICALS as per rules of University		

Unit	**Topic**	**No. of Lectures**
1	(a) i) Metric spaces : Definition, examples including IR with usual distance, discrete Metric Space. ii) Normed linear spaces : definition, the distance(metric) induced by the norm. Examples including (1) IR^n with the sum norm $\| \ \|_1$, Euclidean norm $\| \ \|_2$ and sup norm $\| \ \|_\infty$, if $\| f \|_1 = \int_a^b \|f(t)\| \, dt$, $\| f \|_2 = \left(\int_a^b \|f(t)\|^2 dt\right)^{1/2}$, $\| f \|_\infty = \sup\{\|f(t)\| : t \in [a, b]\}$ iii) Subspaces, product of two matric spaces. (b) (i) Open Ball and open sets in a metric space and subspace Hausdorff property. Interior of a set. (ii) Equivalent Metrics, equivalent norms. (c) (i) Closed set in a metric space (as complement of an open set), Limit point of a set. A closed set contains all its limit points. (ii) Closed Balls, closure of a set, boundary of a set in a metric space. (iii) Distance of a point from a set, distance between two sets, diameter of a set in a metric space.	**15**
2	a) i) Sequences in a metric space ii) The characterization of limit points and closure points in terms of a sequences. iii) Dense subsets in a metric space. Sequences in IR. iv) Cauchy sequences and complete metric spaces. IR^n under Euclidean metric is a complete metric space. b) Cantor's Intersection Theorem .	**15**
3	$\in - \delta$ definition of continuity of a function at a point from one metric space to another. a) Characterization of continuity at a point in terms of sequences, open sets.	**15**

	b) Continuity of a function in a metric space. Characterization in terms of inverse image of open sets and closed sets. c) Algebra of continuous real valued functions. d) Uniform continuity in a metric space. Definition and examples (emphasis on IR).	

Reference Books.

1. T. Apostol. Mathematical Analysis, Second edition, Narosa, New Delhi, 1974
2. E. T. Copson. Metric Spaces. Universal Book Stall, New Delhi, 1996.
3. R. R. Goldberg Methods of Real Analysis, Oxford and IBH Pub. Co., New Delhi 1970.
4. P. K. Jain. K. Ahmed. Metric Spaces. Narosa, New Delhi, 1996.
5. W. Rudin. Principles of Mathematical Analysis, Third Ed, McGraw-Hill, Auckland, 1976.
6. D. Somasundaram, B. Choudhary. A first Course in Mathematical Analysis. Narosa, New Delhi
7. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hii, New York, 1963.

Course: Numerical Analysis

Course Code: USMAMT504

Course outcomes :

- Students are expected to find causes and types of errors, ways to minimize errors.
- Students are expected to study various approximation techniques.
- Students are expected to apply Bisection method, Regula – Falsi method, Secant method, Newton – Raphson method, Muller's method, Chebyshev method, Multipoint iteration method to find a root of transcendental equation.
- Students are expected to obtain rate of convergence of Regula - Falsi method, Secant method, Newton – Raphson method.
- Students are expected to improvise Newton – Raphson method in case of multiple root in view of slower rate of convergence.
- Students are expected to study general iteration methods to obtain fixed points and in turn, roots of transcendental equation.
- Students are expected to use fixed point iteration scheme to obtain rate of convergence of Regula Falsi method, Newton – Raphson method, Chebyshev method.
- Students are expected to guess the number of real roots over positive real axis and negative real axis using Descartes' rule of sign.
- Students are expected to find exact number of real roots over given open, bounded interval using Sturm's sequence.
- Students are expected to obtain smallest root in magnitude of a polynomial using Ramanujan's method.
- Students are expected to obtain linear factor of given real polynomial using Birge – Vieta method.
- Students are expected to obtain quadratic factor, which in turn may give a pair of complex roots, of given real polynomial using Bairstow method.
- Students are expected to obtain all the possible roots of given real polynomial using Graeffe's root square technique.
- Students are expected to obtain solution to system of equations using various direct methods such as Gaussian elimination method, Cramer's rule, Do Little method, Crout's method, Cholesky method.
- Students are expected to find the conditions under which various triangularization methods such as Do Little, Crout, Cholesky are applicable.

- Students are expected to find the conditions under which numerical methods such as Gauss – Jacobi, Gauss – Siedel are applicable.
- Students are expected to obtain solution numerically to system of equations using Gauss – Jacobi method, Gauss – Siedel method.
- Students are expected to obtain approximate eigenvalues graphically Gerschgorin theorem and Brauer's theorem.
- Students are expected to obtain eigenvalues and corresponding eigenvectors of a square, symmetric matrix using Jacobi's method.
- Students are expected to obtain eigenvalues using Rutishauser method.
- Students are expected to obtain largest eigenvalue (in magnitude) and corresponding eigenvector using Power method.
- Students are expected to obtain smallest eigenvalue (in magnitude) and corresponding eigenvector using Inverse Power method.

Learning Outcomes :

- Students should learn to find causes and types of errors, ways to minimize errors.
- Students should learn various approximation techniques.
- Students should learn to apply Bisection method, Regula – Falsi method, Secant method, Newton – Raphson method, Muller's method, Chebyshev method, Multipoint iteration method to find a root of transcendental equation.
- Students should learn to obtain rate of convergence of Regula - Falsi method, Secant method, Newton – Raphson method.
- Students should learn to improvise Newton – Raphson method in case of multiple root in view of slower rate of convergence.
- Students should learn general iteration methods to obtain fixed points and in turn, roots of transcendental equation.
- Students should learn to use fixed point iteration scheme to obtain rate of convergence of Regula Falsi method, Newton – Raphson method, Chebyshev method.
- Students should learn to guess the number of real roots over positive real axis and negative real axis using Descartes' rule of sign.
- Students should learn to find exact number of real roots over given open, bounded interval using Sturm's sequence.

- Students should learn to obtain smallest root in magnitude of a polynomial using Ramanujan's method.
- Students should learn to obtain linear factor of given real polynomial using Birge – Vieta method.
- Students should learn to obtain quadratic factor, which in turn may give a pair of complex roots, of given real polynomial using Bairstow method.
- Students should learn to obtain all the possible roots of given real polynomial using Graeffe's root square technique.
- Students should learn to obtain solution to system of equations using various direct methods such as Gaussian elimination method, Cramer's rule, Do Little method, Crout's method, Cholesky method.
- Students should learn to find the conditions under which various triangularization methods such as Do Little, Crout, Cholesky are applicable.
- Students should learn to find the conditions under which numerical methods such as Gauss – Jacobi, Gauss – Siedel are applicable.
- Students should learn to obtain solution numerically to system of equations using Gauss – Jacobi method, Gauss – Siedel method.
- Students should learn to obtain approximate eigenvalues graphically Gerschgorin theorem and Brauer's theorem.
- Students should learn to obtain eigenvalues and corresponding eigenvectors of a square, symmetric matrix using Jacobi's method.
- Students should learn to obtain eigenvalues using Rutishauser method.
- Students should learn to obtain largest eigenvalue (in magnitude) and corresponding eigenvector using Power method.
- Students should learn to obtain smallest eigenvalue (in magnitude) and corresponding eigenvector using Inverse Power method.

Module I: Transcendental equations (15 Lectures)

(a) Errors, type of errors - relative error, absolute error, round-off error, truncation error. Examples using Taylor's series.

(b) Iteration methods based on first degree equation

(i) The Newton-Raphson method (ii) Secant method (iii) Regula-Falsi method

(c) Iteration methods based on second degree equation - Muller method (problem to be asked only for one iteration), Chebyshev method, multipoint iteration method.

(d) General iteration method - Fixed point iteration method.

(e) Rate of convergence of

(i) The Newton-Raphson method (ii) Secant method (iii) Regula-Falsi method

Reference for Unit I:

(1) M.K. Jain, S.R.K.Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publishers, Fourth Edition, 2003.

(2) B.S. Grewal, Numerical Methods in Engineering and Science. Khanna publishers.

Module II: Polynomial and System of non-linear algebraic equations (15 Lectures)

(a) Descartes' rule of sign

(b) Sturm sequence

(c) Birge - Vieta method

(d) Solving System of non-linear equations using Newton – Raphson method

(e) Bairstow method

(f) Graeffe's roots squaring method

Reference for Unit II:

(1) M.K. Jain, S.R.K.Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publishers, Fourth Edition, 2003.

(2) B.S. Grewal, Numerical Methods in Engineering and Science. Khanna publishers.

Module III: System of linear equations and Eigenvalue problems.(15 Lectures)

(a) Solving Linear systems of equations :

(i) Direct methods - Triangularization methods, Cholesky method

(ii) Iteration methods - Jacobi iteration method, Gauss – Siedel method

(b) Eigenvalues and eigenvectors

(i) Jacobi methods for symmetric matrices

(ii) Rutihauser method for arbitrary matrices

(iii) Power method

(iv) Inverse Power method

Reference for Unit III :

(1) M.K. Jain, S.R.K.Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publishers, Fourth Edition, 2003.

(2) B.S. Grewal, Numerical Methods in Engineering and Science, Khanna publishers.

References :

(1) M.K. Jain, S.R.K.Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publishers, Fourth Edition, 2003.

(2) B.S. Grewal, Numerical Methods in Engineering and Science. Khanna publishers.

(3) S.D. Comte and Carl de Boor, Elementary Numerical analysis - An Algorithmic approach, 3rd Edition., McGraw Hill, International Book Company, 1980.

(4) James B. Scarboraugh, Numerical Mathematical Analysis, Oxford and IBH Publishing Company, New Delhi.

(5) F.B. Hildebrand, Introduction to Numerical Analysis, McGraw Hill, New York, 1956.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.A./ B.Sc . / B.Com(2021-22)	**Semester: V**
Course: Computer Programming and System Analysis - I **Introduction to Python Programming language and application to Mathematics**	**Course Code: USMAACMT5**

Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	-	2	25	75

Learning Objectives:

1) Students should be able to understand the concepts of programming before actually starting to write new programs.
2) Students should be able to understand what happens in the background when the programs are executed
3) Students should be able to develop logic for Problem Solving.
4) Students should be made familiar about the basic constructs of programming such as data, operations, conditions, loops, functions etc.
5) Students should be able to apply the problem solving skills using syntactically simple language i. e. **Python (version: 3.X or higher)**

Course Outcomes:
After completion of the course, learners would be able to:
CO13: Develop problem solving strategies using programming language.
CO14: Understanding data types and expressions, Boolean and Comparison operators and Expressions, Conditional and alternative statements.
CO15: Doing mathematics using python.
CO16: Design user defined function.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Introduction to Python Programming	15 lectures
2	Strings, List, Tuples and Dictionaries	15 lectures
3	Loop, User defined language	15 lectures
4	Doing Math with Python	15 lectures
	Total	60 lectures

Unit	Topic	No. of Hours/Credits
Module 1	**Introduction to Python:** 1. Problem Solving strategies: Problem analysis, formal definition of problem, Methodology of Problem solving, Algorithm, flowcharts. 2. Introduction Python Programming Language, History, features, Installing Python. Running Code in the Interactive Shell, IDLE. Input, Processing, and Output, Editing, Saving, and Running a Script, Debugging: Syntax Errors, Runtime Errors, Semantic Errors, Experimental Debugging. 3. Data types and expressions: Variables and the Assignment Statement, Program Comments. Data Types-Numeric, integers & Floating-point numbers. Boolean, string. Mathematical operators +, - *, ** , %. PEMDAS. Arithmetic expressions, Mixed-Mode Arithmetic and type Conversion, type( ), Input( ), print( ), program comments. id( ), int( ), str( ), float( ). 4. Boolean and Comparison operators and Expressions, Conditional and alternative statements- Chained and Nested Conditionals: if, if-else, if-elif-else, nested if, nested if-else. Compound Boolean Expressions.	**15 lectures**
Module 2	**STRINGS, LIST, TUPLES AND DICTIONARIES** 1. Strings: Accessing characters, indexing, slicing, replacing. Concatenation (+), Repetition (*).Searching a substring with the 'in' Operator, Traversing string using while and for. String methods- find, join, split, lower, upper. len( ). 2. Lists – Accessing and slicing, Basic Operations (Comparison, +), List membership and for loop. Replacing element (list is mutable). List methods- append, extend, insert, pop, sort, max( ), min( ), Tuples.	**15 lectures**

	3. Dictionaries-Creating a Dictionary, Adding keys and replacing Values, dictionary key( ), value( ), get( ), pop( ) , Traversing a Dictionary.	
Module 3	**LOOP, USER DEFINED FUNCTION:** 1. Definite Iteration: The for Loop, Executing statements a given number of times , Specifying the steps using range( ), Loops that count down, Conditional Iteration: The while Loop –with True condition, the break Statement 2. Math module: sin(), cos(), exp(), sqrt(), constants- pi, e etc. 3. Design with functions: Defining Simple Functions-Parameters and Arguments, the return Statement, Boolean Functions. Defining a main function. Defining and tracing recursive functions.	**15 lectures**
Module 4	**DOING MATH WITH PYTHON** 1. Working with Numbers: Calculating the Factors of an Integer, Generating Multiplication Tables, converting units of Measurement, Finding the roots of a Quadratic Equation, etc. **2.** Exploring Algebra and Symbolic Math with SymPy: SymPy as calculator, application to calculus, equation solving, linear algebra differential equation etc.	**15 lectures**

PRACTICALS

(1) Installing python and setting up environment. Simple statements like printing the names, numbers, mathematical calculations, etc.
(2) Simple programs containing variable declaration and arithmetic operations
(3) Programs based on conditional constructs
(4) Programs based on loops
(5) Programs related to string manipulation
(6) Programs related to Lists, Tuples

(7) Programs related to dictionaries
(8) Programs related to functions & modules
(9) Programs to do symbolic mathematics

Suggested Readings

1. Downey, A. et al., How to think like a Computer Scientist: Learning with Python, John Wiley.
2. Goel, A., Computer Fundamentals, Pearson Education.
3. Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India.
4. Rajaraman, V., Computer Basics and C Programming, Prentice-Hall India.
5. Barry, P., Head First Python, O Reilly Publishers.
6. Dromy, R. G., How to solve it by Computer, Pearson India.
7. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
8. Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley.
9. Sprankle, M., Problem Solving & Programming Concepts, Pearson India.
10. Venit, S. and Drake, E., Prelude to Programming: Concepts & Design, Pearson India.
11. Zelle, J., Python Programming: An Introduction to Computer Science, Franklin, Beedle & Associates Inc.
12. Doing Math with Python - Amit Saha, No starch ptress,
13. Problem solving and Python programming- E. Balgurusamy, TataMcGrawHill.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

DEPARTMENT OF MATHEMATICS

SYLLABUS

SEMESTER VI

<table>
<tr><td colspan="4">Program: B.Sc . (2021-22)</td><td colspan="2">Semester: VI</td></tr>
<tr><td colspan="4">Course: Real and Complex Analysis</td><td colspan="2">Course Code:USMAMT 601</td></tr>
<tr><td colspan="4">Teaching Scheme</td><td colspan="2">Evaluation Scheme</td></tr>
<tr><td>Lecture (per week) 48 mins× 3</td><td>Practical (lectures per week) 48 mins× 3</td><td>Tutorial (Hours per week)</td><td>Credit</td><td>Continuous Assessment (CA) (Marks - 25)</td><td>Semester End Examinations (SEE) (Marks- 75 in Question Paper)</td></tr>
<tr><td>3</td><td>3</td><td>NIL</td><td>4</td><td>25</td><td>75</td></tr>
</table>

Learning Objectives:

1. To develop in students the Mathematical analysis how to use the definitions, results to solve problems.
2.Demonstrate how complex numbers provides a satisfying extension of real numbers to study the properties of complex valued function .

Course Outcomes:
After completion of the course, learners would be able to:
CO1:Understand the theory of sequence and series of functions , power series, special power series and their properties like continuity, differentiability, integrability.
CO2.Understand to discuss pointwise ,uniform convergence of sequence and series of functions on the given domain.
Co3.Understand the application of Cauchy-Riemann equation to determine the differentiability and analyticity of a complex valued function.
CO4.Understand the the application of Cauchy integral formula to evaluate contour integral.
CO5.understand to find the Taylor and Laurent series of a function and determine its circle or annulus of convergence.
CO6.Understand to compute the residue of a function and use the residue theory to evaluate a contour integral or integral over the domain in complex plane.

Outline of Syllabus: (per session plan)

Module	Description	No of Lectures
1	**Sequence and Series of Functions, Power Series**	15
2	**Introduction to Complex Analysis**	15
3	**Complex Integration and Complex Power series**	15
	Total	**45**

PRACTICALS: 48 mins× 3 per batch per week

Module	Topic	No. of lectures/Credits
1	(i) Pointwise and uniform convergence of sequences and series of real-valued functions. Weierstrass M-test. Examples. (ii) Continuity of the uniform limit of a sequence of real-valued functions. Continuity of the uniform sum of a series of real-valued functions. The integral and the derivative of the uniform limit of a sequence of real-valued functions on a closed and bounded interval. Examples. The integral and the derivative of the uniform sum of a series of real-valued functions on a closed and bounded interval. Examples. (iii) Power series in R. Radius of convergence. Region of convergence. Uniform convergence. Term-by-term differentiation and integration of power series. Examples. (iv) Classical functions defined by power series such as exponential, cosine and sine functions, and the basic properties of these functions.	15/ 2.5
2	(i)Review of complex numbers: complex plane, polar co-ordinates, exponential map, powers and roots of complex numbers, De Moivre's formula (ii) Point at infinity-extended complex plane. Limit at a point and results on it, Functions f : $\mathbb{C} \rightarrow \mathbb{C}$ real and imaginary part of functions ,continuity at a point and algebra of continuous functions (iv) Derivative of f : $\mathbb{C} \rightarrow \mathbb{C}$, comparison between differentiability in real and complex sense, Cauchy-Riemann equations, sufficient conditions for differentiability, analytic functions. Algebra of Analytic functions. Properties of Analytic functions.	15/ 2.5

	(v)Harmonic functions and harmonic conjugate. Milne-Thompson method to find harmonic conjugate, Orthogonal trajectories.	
3	**(i)Line integral and Contour integral over ℂ.ML Inequality. Cauchy's Inequality. Cauchy-Goursat theorem . Extension of Cauchy integral formula.** **(ii) Taylor Theorem for analytic function, Mobius transformation-definition and examples. Exponential, trigonometric and hyperbolic functions.** **(iv)Power series of complex numbers, radius of convergences, disc of convergence and uniqueness of series representation, examples, Definition of Laurent series expansion of complex function.** **(v) Singularity and types of singularity. Residue at singularity. Cauchy's Residue Theorem (statement only) and calculation of residue.**	**15/ 2.5**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I

- Practicals will be conducted as per University notified list
- one practical(of three lectures) per week per batch.
- Batches will be formed as University norms

Program: B.A./ B.Sc . / B.Com(2021-22)					**Semester: VI**
Course: Algebra					**Course Code: USMAMT602**
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
3	3	-	2.5	25	75

Learning Objectives:

- Students will be knowledgeable of different types of subgroups such as normal subgroups, quotient group and understand the structure and characteristics of these subgroups.
- Students will have a working knowledge of important mathematical concepts in abstract algebra such rings,
  Ideals, integral domain, principal ideal, homomorphism and isomorphism.
- Students will be introduced to and have knowledge of many mathematical concepts studied in abstract mathematics such as polynomial ring, Euclidean domain, principal ideal domain and unique factorization domain.

Course Outcomes:

After completion of the course, learners would be able to:

CO5: Develop proofs of results on Normal groups, Quotient groups
CO6: Test the homomorphic and isomorphic properties of groups and rings
CO7: Explain the properties of rings and different types Ideals of ring
CO8: Develop the concepts of Principal ideal domains, Euclidean domains and Unique Factorisation Domains
CO9: Apply the theory of Groups and Rings and solve problems

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Cosets, Normal Group, Quotient Group, Group Homomorphism	15 lectures
2	Ring and Field Theory	15 lectures
3	PID, ED, UFD	15 lectures
	Total	45 lectures

Unit	Topic	No. of Hours/Credits
Module 1	(a) Definition of Coset and properties, Lagrange's theorem and consequences, (b) Normal subgroups of a group, Center of a group is normal, Quotient group. Alternating group. (c)Group homomorphism's and isomorphism's. Examples and properties. Automorphisms of a group, inner automorphisms First Isomorphism theorem (or Fundamental Theorem of homomorphisms of groups). (d)Cayley's theorem. External direct product of a group. Properties of external direct products. Order of an element in a direct product, criterion for direct product to be cyclic.	**15 lectures**
Module 2	(a)Definition of a ring. (The definition should include the existence of a unity element.) Properties and examples of rings (b)Commutative rings. Units in a ring. The multiplicative group of units of a ring. (c)Characteristic of a ring. Ring homomorphisms. First Isomorphism theorem of rings. (d)Ideals in a ring, sum and product of ideals in a commutative ring. Quotient rings. Integral domains and fields. Definition and examples. A finite integral domain is a field. Characteristic of an integral domain, and of a finite field. A field contains a subfield isomorphic to Zp or Q.	**15 lectures**
Module 3	(a)Prime ideals and maximal ideals. Definition and examples. Characterization in terms of quotient rings.	**15 lectures**

	(b)Polynomial rings. Irreducible polynomials over an integral domain. Unique Factorization Theorem for polynomials over a field. (c)Divisibility in an integral domain, irreducible and prime elements, ideals generated by prime and irreducible elements. (d)Definition of a Euclidean domain (ED), Principal Ideal Domain (PID), Unique Factorization Domain (UFD). Examples of ED: Z, F[X], where F is a field, and Z[i]. An ED is a PID, a PID is a UFD. Prime (irreducible) elements in R[X], Q[X], Zp[X]. Prime and maximal ideals in polynomial rings. Z[X] is not a PID. Z[X] is a UFD (Statement only).	

PRACTICALS

1. Practical on Cosets and normal groups
2. Practical on quotient group and group homomorphism
3. Practical on ring, ideals and characteristics of a ring
4. Practical on integral domain and ring homomorphism
5. Practical on quotient ring and field
6. Practical on polynomial rings
7. Practical on PID, ED and UFD

Suggested Readings

(1) I.N. Herstein, Topics in Algebra.
(2) P.B. Bhattacharya, S.K. Jain, S. Nagpaul. Abstract Algebra.

Program: B.Sc . (2021-22)					**Semester: VI**
Course: Analysis					**Course Code:USMAMT 603**
Teaching Scheme				**Evaluation Scheme**	
Lecture Per week	**Practical (per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
3	3 lecture	NIL	4	25	75

Learning Objectives:

1) To give theoretical foundation for key concepts-Compact and Connected sets appearing in Analysis.This will be done in the context of Metric Spaces.
2) To understand properties of Fourier Series.
   Appreciate that Fourier Series are the mathematical form for periodic physical phenomena and to use Fourier Series to represent periodic phenomena.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Practise the expansion of Fourier Series and utilize the same for higher studies

CO2: Will be able to represent periodic functions using Fourier Series.

CO3: Prove basic results on Compactness and Connectedness and convergence within these structures.

CO4: Will be able to understand and able to work with various notions of Compactness and know the relations with other Topological and metric properties

Outline of Syllabus: (per session plan)

Unit	Description	No of lectures
1	Connected Metric Spaces	15
2	Compact Metric Spaces	15
3	Fourier Series	15
	Total	**45**
PRACTICALS As per rules of University		

Unit	**Topic**	**No. of Lectures**
1	a) i) Connected Metric Spaces – Determination and examples ii) Characterization of a connected space, viz. a metric space X is connected if every continuous function from X to $\{-1, 1\}$ is a constant function. iii) Connected subsets of a metric space, connected subsets of IR. iv) A continuous image of a connected set is connected. b) i) Path connectedness in IR^n, definitions and examples. ii) A path connected subset of IR^n which is connected. iii) An example of a connected subset of IR^n which is not path connected. c) Convex sets are path-connected d) Connected components	**15**
2	a) Definition of a compact set in a metric space. Examples, properties such as i) Continuous image of a compact set is compact ii) Compact sets are closed and bounded iii) Continuous function on a compact set is uniformly continuous. b) Characterization of compact sets in IR^n. The equivalent statements for a subset of IR^n to be compact – i) Heine – Borel property ii) Closed and boundedness property iii) Bolzano – Weierstrass property iv) Sequentially compactness property	**15**
3	a) Fourier series of functions on $C[-\pi, \pi]$ b) Dirichlet Kernel, Fejer Kernel, Cesaro summability of Fourier Series of function on $C[-\pi, \pi]$ **c)** Bessel's inequality and Parseval's identity	**15**

Reference Books.

1. T. Apostol. Mathematical Analysis, Second edition, Narosa, New Delhi, 1974
2. E. T. Copson. Metric Spaces. Universal Book Stall, New Delhi, 1996.
3. R. R. Goldberg Methods of Real Analysis, Oxford and IBH Pub. Co., New Delhi 1970.
4. P. K. Jain. K. Ahmed. Metric Spaces. Narosa, New Delhi, 1996.
5. W. Rudin. Principles of Mathematical Analysis, Third Ed, McGraw-Hill, Auckland, 1976.
6. D. Somasundaram, B. Choudhary. A first Course in Mathematical Analysis. Narosa, New Delhi
7. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hii, New York, 1963.

Course : Numerical Analysis

Course Code : USMAMT604

Course outcomes :

- Students are expected to find polynomial approximation to the given data using Lagrange's interpolation for uneven data.
- Students are expected to find polynomial approximation to the given data using Iterated interpolation for uneven data.
- Students are expected to find polynomial approximation to the given data using Newton's divided difference formula for uneven data.
- Students are expected to investigate relationship between various interpolating operators.
- Students are expected to find polynomial approximation to the given data using Gregory – Newton forward/backward interpolation for evenly distributed data.
- Students are expected to find polynomial approximation to the given bivariate data using Lagrange's bivariate interpolation formula.
- Students are expected to find polynomial approximation to the given bivariate data using Gregory – Newton bivariate interpolation formula.
- Students are expected to find a rate of change of unknown function at a specific point using discrete set of values using first order as well as second order formulae.
- Students are expected to find first/second derivative of unknown function at a specific point using discrete set of values.
- Students are expected to find first order partial derivative of unknown function at a specific point using bivariate discrete data using first order as well as second order formulae.
- Students are expected to find second order mixed partial derivative of unknown function at a specific point using bivariate discrete data using second order formula.
- Students are expected to integrate unknown function using trapezoidal rule(both simple as well as composite forms)
- Students are expected to evaluate order of trapezoidal rule.

- Students are expected to find double integration of unknown function using trapezoidal rule.
- Students are expected to integrate unknown function using Simpson's $1/3^{rd}$ rule(both simple as well as composite forms)
- Students are expected to evaluate order of Simpson's $1/3^{rd}$ rule
- Students are expected to find double integration of unknown function using Simpson's $1/3^{rd}$ rule.
- Students are expected to integrate unknown function using Simpson's $3/8^{th}$ rule(both simple as well as composite forms)
- Students are expected to evaluate order of Simpson's $3/8^{th}$ rule
- Students are expected to find double integration of unknown function using Simpson's $3/8^{th}$ rule.
- Students are expected to find double integration of unknown function using mixture of the formulae.
- Students are expected to find integration of a bounded function over a balanced interval, [–1, 1] using Gauss – Legendre 1 – point as well as 2 – point formulae.
- Students are expected to find integration of a bounded function over a bounded interval, [a, b] using Gauss – Legendre 1 – point as well as 2 – point formulae.
- Students are expected to find improper integral of over a balanced interval, [–1, 1] using Gauss – Chebyshev 1 – point as well as 2 – point formulae.
- Students are expected to find improper integral of over a bounded interval, [a, b] using Gauss – Chebyshev 1 – point as well as 2 – point formulae.
- Students are expected to estimate y(x) based on given IVP using Taylor series approximation.
- Students are expected to estimate y(x) based on given IVP using Picard's approximation.
- Students are expected to estimate y(x) numerically, based on given IVP using Euler's formula.
- Students are expected to estimate y(x) numerically, based on given IVP using modified Euler's formulae such as Heun's method, Polygon method.
- Students are expected to estimate y(x) numerically, based on given IVP using Runge – Kutta methods of order 2 and of order 4.
- Students are expected to estimate y(x) numerically, based on given IVP using multi-step Milne – Simpson's method of order 4.
- Students are expected to estimate y(x) numerically, based on given IVP using multi-step Adam-Bashforth-Moulton's method of order 4.

Learning Outcomes :

- Students should learn to find polynomial approximation to the given data using Lagrange's interpolation for uneven data.
- Students should learn to find polynomial approximation to the given data using Iterated interpolation for uneven data.
- Students should learn to find polynomial approximation to the given data using Newton's divided difference formula for uneven data.
- Students should learn to investigate relationship between various interpolating operators.
- Students should learn to find polynomial approximation to the given data using Gregory – Newton forward/backward interpolation for evenly distributed data.
- Students should learn to find polynomial approximation to the given bivariate data using Lagrange's bivariate interpolation formula.
- Students should learn to find polynomial approximation to the given bivariate data using Gregory – Newton bivariate interpolation formula.
- Students should learn to find a rate of change of unknown function at a specific point using discrete set of values using first order as well as second order formulae.
- Students should learn to find first/second derivative of unknown function at a specific point using discrete set of values.
- Students should learn to find first order partial derivative of unknown function at a specific point using bivariate discrete data using first order as well as second order formulae.
- Students should learn to find second order mixed partial derivative of unknown function at a specific point using bivariate discrete data using second order formula.
- Students should learn to integrate unknown function using trapezoidal rule(both simple as well as composite forms)
- Students should learn to evaluate order of trapezoidal rule.
- Students should learn to find double integration of unknown function using trapezoidal rule.
- Students should learn to integrate unknown function using Simpson's $1/3^{rd}$ rule(both simple as well as composite forms)
- Students should learn to evaluate order of Simpson's $1/3^{rd}$ rule
- Students should learn to find double integration of unknown function using Simpson's $1/3^{rd}$ rule.

- Students should learn to integrate unknown function using Simpson's $3/8^{th}$ rule(both simple as well as composite forms)
- Students should learn to evaluate order of Simpson's $3/8^{th}$ rule
- Students should learn to find double integration of unknown function using Simpson's $3/8^{th}$ rule.
- Students should learn to find double integration of unknown function using mixture of the formulae.
- Students should learn to find integration of a bounded function over a balanced interval, [–1, 1] using Gauss – Legendre 1 – point as well as 2 – point formulae.
- Students should learn to find integration of a bounded function over a bounded interval, [a, b] using Gauss – Legendre 1 – point as well as 2 – point formulae.
- Students should learn to find improper integral of over a balanced interval, [–1, 1] using Gauss – Chebyshev 1 – point as well as 2 – point formulae.
- Students should learn to find improper integral of over a bounded interval, [a, b] using Gauss – Chebyshev 1 – point as well as 2 – point formulae.
- Students should learn to estimate y(x) based on given IVP using Taylor series approximation.
- Students should learn to estimate y(x) based on given IVP using Picard's approximation.
- Students should learn to estimate y(x) numerically, based on given IVP using Euler's formula.
- Students should learn to estimate y(x) numerically, based on given IVP using modified Euler's formulae such as Heun's method, Polygon method.
- Students should learn to estimate y(x) numerically, based on given IVP using Runge – Kutta methods of order 2 and of order 4.
- Students should learn to estimate y(x) numerically, based on given IVP using multi-step Milne – Simpson's method of order 4.
- Students should learn to estimate y(x) numerically, based on given IVP using multi-step Adam-Bashforth-Moulton's method of order 4.

Unit I: Interpolation (15 Lectures)

(a) Lagrange's Linear, quadratic and higher order Interpolation
(b) Iterated interpolation, Newton's divided difference interpolation
(c) Finite difference operators
(d) Interpolating polynomial using finite differences
(e) Piecewise linear and quadratic interpolation
(f) Bivariate interpolation - Newton's bivariate interpolation for equi-spaced points

Reference for Unit I:

(1) M.K.Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publishers, Fourth Edition, 2003

Unit II: Numerical Differentiation and Integration (15 Lectures)

(a) Numerical differentiation
(i) Methods based on Interpolation (linear and quadratic)
(ii) Partial differentiation
(b) Methods based on interpolation - Trapezoidal rule, Simpson's rule
(c) Method based on undetermined coefficients –: Gauss-Legendre/Gauss-Chebyshev integration method (one point formula, two point formula)
(d) Composite integration methods - Trapezoidal rule, Simpson's rule
(e) Double integration - Trapezoidal method, simpson's method.

Reference for Unit II :

(1) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publishers, Fourth Edition, 2003.

Unit III: Solving Initial Value Problem (15 Lectures)

(a) Solution of Initial value problem of an ordinary first order differential equation:
One step methods: Taylor series method, Picard's method, Euler's method, Heun's method, Polygon method, Runge-Kutta method of 2nd order, 4th order.
(b) Solution of Initial value problem of an ordinary first order differential equation:
Multistep methods (Predictor - Corrector methods) : Milne-Simpson method, Adams–Bashforth-Moulton method

Reference for Unit III:

(1) Chapter 13, Sections 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.9 and of Numerical Methods, E. Balaguruswamy, TATA McGraw Hill.

Recommended Books

1. G.B. Thomas and R. L. Finney: Calculus and Analytic Geometry, Ninth Edition, Addison-Wesley, 1998.
2. E. Balaguruswamy : Numerical Methods, TATA McGraw Hill.

Additional Reference Books

(1) Graham, Knuth and Patashnik: Concrete Mathematics, Pearson Education Asia Low Price Edition.
(2) Kendall Atkinson : An Introduction to Numerical Analysis, Wiley Student Edition.
(3) Richard Burden and Douglas Faires: Numerical Analysis, Thomson Books/Cole.
(4) Thomas H. Cormen, Charles E. Leisenon and Ronald L. Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi, 1998 Edition
(5) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International publishers, Fourth Edition, 2003.

(6) B.S. Grewal, Numerical Methods in Engineering and Science. Khanna publishers.
(7) S.D. Comte and Carl de Boor, Elementary Numerical analysis - An Algorithmic approach, 3rd Edition., McGraw Hill, International Book Company, 1980.
(8) James B. Scarboraugh, Numerical Mathematical Analysis, Oxford and IBH Publishing Company, New Delhi.
(5) F.B. Hildebrand, Introduction to Numerical Analysis, McGraw Hill, New York, 1956.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.A./ B.Sc . / B.Com(2021-22)	**Semester: VI**
Course: Computer Programming and System Analysis - I **Python Programming and Data Science using Python**	**Course Code: USMAACMT6**

Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	-	2	25	75

Learning Objectives:

1. To introduce the concept of machine learning and data science.
2. To present various Machine Learning algorithms and their applications
3. To show to the implementation of Machine Learning techniques with hands on sessions
4. To understand python packages used for data.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Understand multidimensional numerical data
CO2: To create, format and clean data
CO3: Able to plot the data
CO4: To explore data science and build a model in Python

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Numpy	15 lectures
2	Pandas	15 lectures
3	Scipy, Matplotlib, Introduction to data science	15 lectures
4	Exploring data science and Building a Model in Python	15 lectures
	Total	60 lectures

Unit	Topic	No. of Hours/Credits
Module 1	**Numpy** N-dimensional array(ndarray), Data Types, array attributes, array creation, array from numerical range, indexing or slicing of ndarrray, array manipulation, arithmetic operation, mathematical function, statistical function, sorting, matrix library, basic linear algebra etc.	**15 lectures**
Module 2	**Pandas** Data structure in Pandas, Pandas series and its basic functionality, DataFrame's structure, creation of DataFrame, Basic functionality of DataFrame, Descriptive statistics, Sorting by label and values, Time series, Date functionality , Pandas visualization etc	**15 lectures**
Module 3	**Scipy, Matplotlib, Introduction to Machine learning** Exploring libraries basic functionality of Scipy and Matplotlib with the application to mathematics. Introduction to big data, data science, its benefits and uses, Facets of data, Structured data, Unstructured data, Natural language, Machine-generated data, Graph-based or network data, Audio, image, and video, Streaming data. The data science process, Introduction concept of Machine learning, Its Applications. Python tools used in machine learning etc. Types of machine learning, supervised learning, unsupervised learning, Semi-supervised learning.	**15 lectures**
Module 4	**Exploratory data analysis and Building a Model in Python**	**15 lectures**

	Retrieving data, Cleansing, integrating, and transforming data, Exploratory data analysis Build the models, Load data file(s), To convert a variable to different data type, transpose a table, To sort Data, create plots (Histogram, Scatter, Box Plot), To do sampling of Data set, to remove missing value duplicate values of a variable, to group variables to calculate count, average, sum, to recognize and treat missing values and outliers, to merge / join data set effectively **Building a Model in Python** Linear Regression, Logistic Regression, K-means clustering.	

PRACTICALS

(1) Installing python packages: Numpy, Scipy, Pandas, matplotlib and sklearn
(2) Programs based on Numpy
(3) Programs based on Scipy
(4) Programs based on Pandas
(5) Programs related to matplotlib
(6) Programs related to data preprocessing
(7) Programs to build linear regression model and logistic regression
(8) Programs to build K-means

Suggested Readings

1. Downey, A. et al., How to think like a Computer Scientist: Learning with Python, John Wiley.
2. Goel, A., Computer Fundamentals, Pearson Education.
3. Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India.
4. Rajaraman, V., Computer Basics and C Programming, Prentice-Hall India.
5. Barry, P., Head First Python, O Reilly Publishers.
6. Dromy, R. G., How to solve it by Computer, Pearson India.
7. Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India.
8. Perkovic, L., Introduction to Computing Using Python, , John Wiley.
9. Sprankle, M., Problem Solving & Programming Concepts, Pearson India.
10. Venit, S. and Drake, E., Prelude to Programming: Concepts & Design, Pearson India.
11. Zelle, J., Python Programming: An Introduction to Computer Science, Franklin, Beedle & Associates Inc.
12. Doing Math with Python - Amit Saha, No starch ptress,
13. Problem solving and Python programming- E. Balgurusamy, TataMcGrawHill.